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Investigating the submerged prehistory of the eastern Adriatic

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Investigating the Submerged Prehistory of the Eastern Adriatic: progress and prospects

*Jonathan Benjamin, Luka Bekić, Darko Komšo,
Ida Koncani Uhač and Clive Bonsall*

In this paper we assess the potential for the survival and investigation of submerged prehistoric sites and cultural landscapes in the eastern Adriatic. We review previous underwater prehistoric finds from the region and evaluate their significance. Most of these finds were made in shallow water close inshore and likely date to the Neolithic–Early Bronze Age. We discuss the reasons for this pattern and for the concentration of finds along the Istrian and Dalmatian coasts. The prospects for finding submerged sites belonging to earlier periods of prehistory are discussed, with emphasis on the crucial period between 7000 and 5500 cal BC during which farming and herding supplanted hunting, fishing, and gathering as the dominant modes of subsistence. Against this background, we present a research design for a multidisciplinary study of submerged landscapes around one of the larger islands of the Zadar archipelago. It is suggested that some important questions of the processes and timing of the transition to farming around the Adriatic Basin may only be answered through the investigation of the continental shelf, and that such research can also contribute to a better understanding of Holocene sea-level and coastal change.

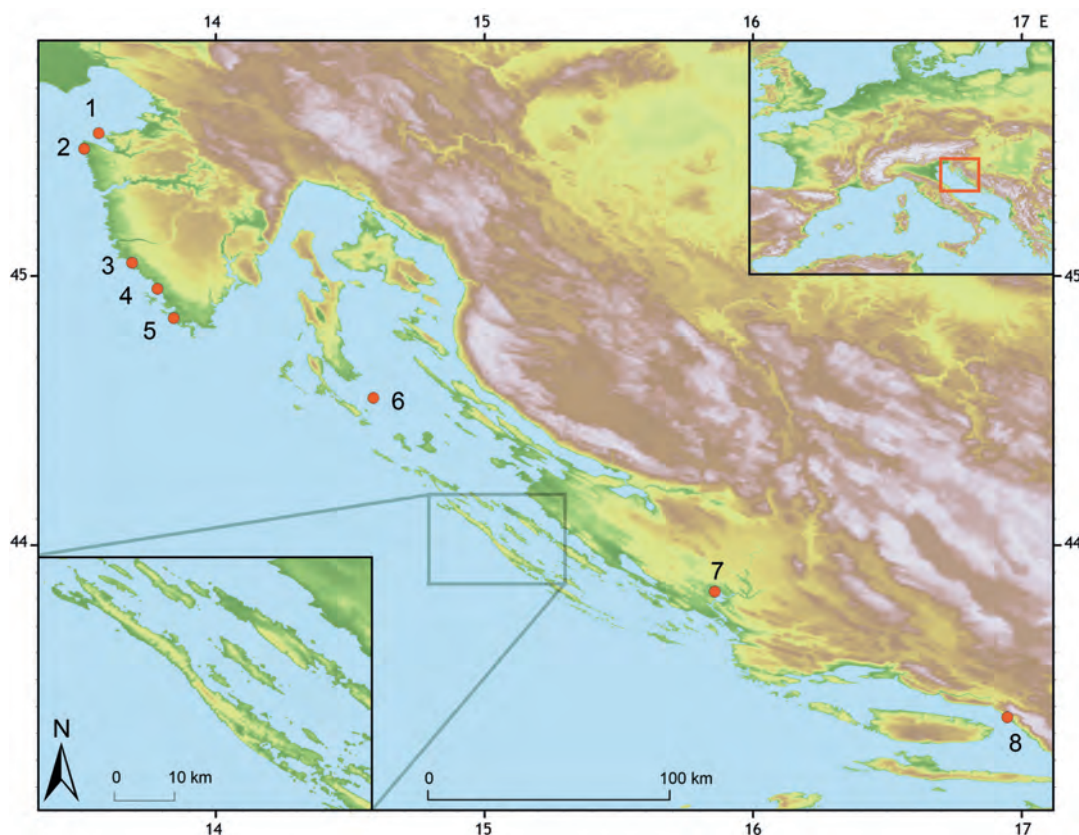
Keywords: eastern Adriatic, sea-level rise, submerged cultural landscapes, Mesolithic–Neolithic transition

Introduction

Underwater archaeological investigations along the eastern Adriatic coast traditionally have focused on Classical, maritime, and shipwreck archaeology (cf. Jurišić 2000; Radić Rossi *et al.* 2008; Bekić 2009a). However, the region has a rich prehistory and studies of post-glacial sea-level change and shoreline displacement suggest there is potential for the discovery of underwater prehistoric sites dating back to the Early Holocene or even the Late Pleistocene, at locations and depths that are accessible to archaeological divers. Since relative sea level along the eastern Adriatic rim is higher today than at any stage of

prehistory, many low-lying coastal sites must have been transgressed. Dalmatia, in particular, with its varied coastal landscape comprising thousands of islands, protected embayments, straits and, importantly, submarine caves, is a region of high potential for underwater site discovery. In this paper we review past research into the submerged prehistory of the eastern Adriatic Sea, reporting on some previously unpublished finds. We also discuss the prospects for future research aimed at recovering new evidence from the seabed that could revolutionize our understanding of some of the key events in the prehistory of the region, such as the introduction and spread of farming.

Figure 16.1: Locations of underwater prehistoric finds from the eastern Adriatic. 1 Punta Piran, 2 Zambratija Cove, 3 Veštar Bay, 4 Cap Gale, 5 Veruda Bay, 6 Oruda, 7 Stripanac, 8 Baška Voda (SRTM digital elevation data, after Jarvis et al. 2008)



Previous finds

At least eight submerged sites or localities with prehistoric artefacts have been reported along the eastern Adriatic coast between Piran in Slovenia and Makarska in Croatia (Fig. 16.1).

Figure 16.2: Punta Piran, Slovenia. The bifacial dagger blade found during underwater survey in 2005 (Photo: J. Benjamin)

Punta Piran

The only well-documented prehistoric find from the Slovenian sector of the Adriatic Sea was a single chert artefact recovered from the seabed

at 26 m depth in front of the headland of Punta Piran (Fig. 16.1). It was found in 2005 during an underwater survey directed by Jonathan Benjamin (Benjamin 2007; Benjamin and Bonsall 2009a). The artefact, described as a small bifacial dagger or 'fixed blade' knife (Fig. 16.2), compares closely in form and raw material to northern Italian Chalcolithic and Bavarian Final Neolithic examples, and probably originated in the northeast Italian Pre-Alpine region. The depth at which the artefact was found suggests it was not in a primary context, or was lost at sea during its time of use (for discussion, see Benjamin and Bonsall 2009b).

Zambratija Cove, Savudrija

In September 2008, the Archaeological Museum of Istria (Pula) began an underwater rescue project around the Bay of Zambratija in northwestern Istria, not far from Savudrija (Fig. 16.1; Koncani Uhač 2009). While excavation of a shipwreck was in progress along the southern shore of the bay (Fig. 16.3), a survey of the northern shore was conducted. It was here that wooden remains were observed (Fig. 16.4). In places the timbers protruded from the sandy seabed sediments, forming a more-or-less circular pattern.

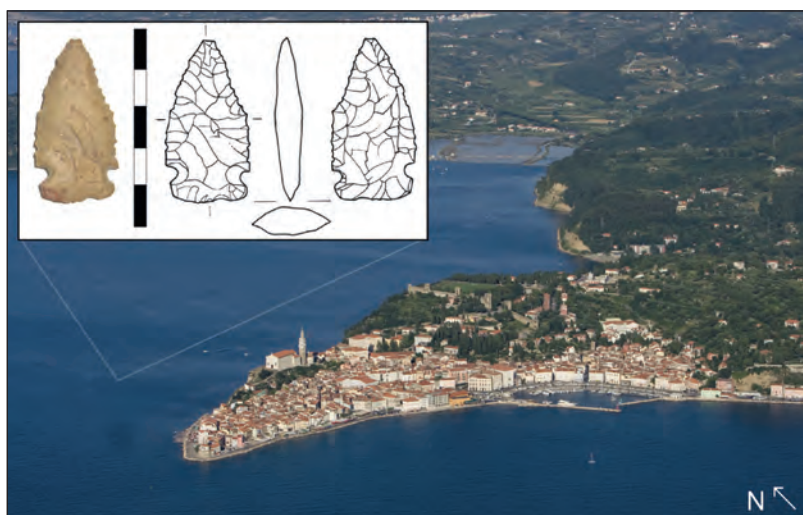




Figure 16.3: Zambratija Cove. The submerged prehistoric site is located in the northern part of the bay (Photo: J. Benjamin)

A 2×1 m test-pit was excavated where the wood remains were most densely concentrated. The seabed in this area is composed of sand and seagrass and the top of a round wooden post was visible at an absolute depth of 2.36 m. After removal of the seabed sediments with a hand-held water dredge, a 5 cm thick layer of grey mud containing traces of burning was encountered; the top of the wooden post also exhibited signs of burning. Pottery sherds and animal bones were found in this grey mud layer. Below the grey mud was a 0.54 m thick layer of fine, compact, darker grey mud with numerous sherds of prehistoric pottery and bones of cattle, small game, and fish. Within this layer four vertically placed posts, with two posts lying diagonally between them, were documented. Underneath the posts, at an absolute depth of 3.09 m, horizontally aligned timbers – thought to be the remains of a house floor – were uncovered. Since the field research was time restricted, the excavation was suspended at this point and the site protected with geotextile in accordance with standard archaeological practice. The archaeological materials recovered were sent for specialist analyses, and samples of bone and wood were taken for ^{14}C dating.

Underwater survey revealed a total of 34 wooden posts over an area of approximately 6500 m². The archaeological remains occur between 2.4 m and 3.1 m absolute depth. Preliminary analysis of the pottery suggests the site belongs broadly to the time-range from the Middle Neolithic to the Early Bronze Age.

The discovery of the site at Zambratija raises questions about the human consequences of the Holocene marine transgression in the eastern Adriatic. Was the transgression the primary reason for the abandonment of the site? Was the site built directly adjacent to the shore, or even partially (or entirely) above water? Or was the site located some distance from the actual shore

during its occupation? Further investigations at Zambratija Cove, and research into regional sea-level change are needed if these questions are to be answered.

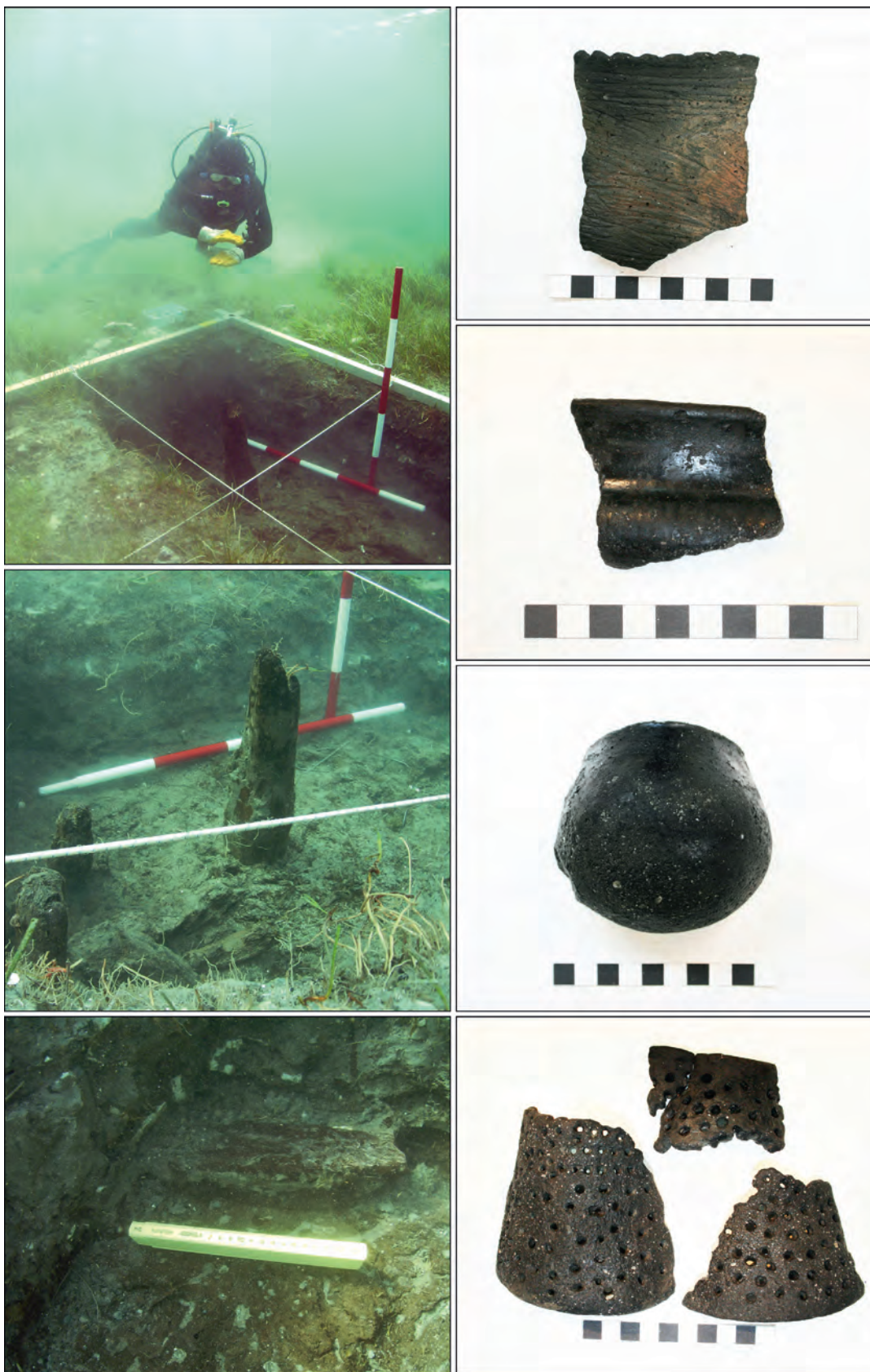
Veštar Bay

Veštar is a large bay with a flat, shallow bottom just a few metres deep (Fig. 16.1). Previous underwater finds from the bay include Roman, Medieval, and Post-Medieval artefacts, and the remains of a Roman stone-built breakwater (Bekić 2001, 2009b), although prehistoric sites are known from the surrounding area (Bekić 1996; Komšo 2008).

Underwater surveys directed by Luka Bekić between 2000 and 2009 recovered five pieces of chert from the seabed, from a zone extending for about a hundred metres along the southern shore of the bay. No prehistoric pottery was found in this area, although local informants have reported finding more chert – including a distinctive red-brown variety (see below) – on the adjacent beach. The chert pieces (Fig. 16.5) were found at absolute depths of between 1.5 m and 2.5 m; three were found directly on the seabed, and the other two in loose sediment just below the seafloor. The condition of some of the chert pieces and the contexts in which they occurred suggest they were not in a primary position.

A preliminary analysis (by Darko Komšo) suggests that at least one of the chert pieces is an artefact (Fig. 16.5, 3). This is a fragment of a bladelet with abrupt retouch along one lateral edge and traces of ‘sickle gloss’ along the opposing edge. Similar finds are known from Neolithic and Copper Age sites (Chalcolithic, also known as Eneolithic) in the region (cf. Codacci 2002; Komšo 2004; Forenbaher and Nikitović 2007; Komšo *et al.* 2009). None of the other four chert pieces shows clear signs of working. The largest piece (Fig. 16.5, 1) – a

Figure 16.4: Images of the prehistoric site in Zambratija Cove and examples of pottery from the grey mud layer (Photos: I. Koncani Uhač)

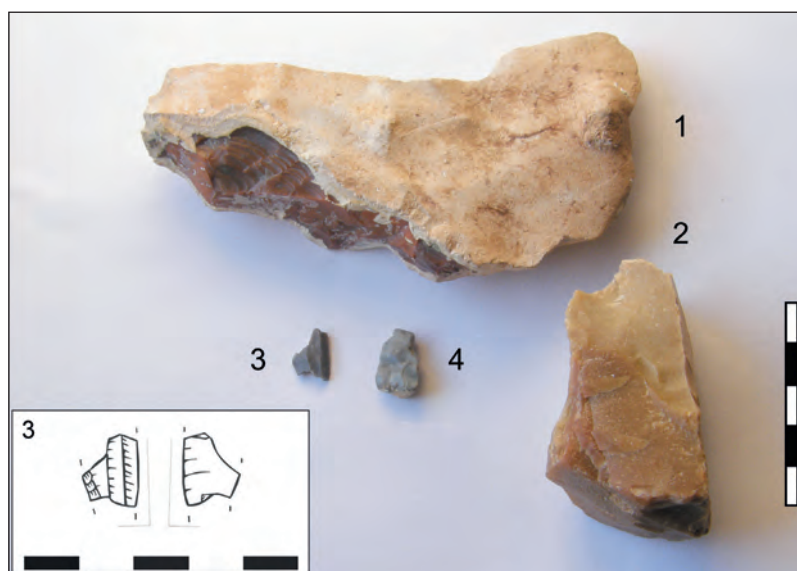


fragment of a nodule with pale-brown ‘chalky’ cortex – exhibits a number of mechanical fractures, although none of these is necessarily man made. The material is dark red to brown in colour, and of high quality. No outcrops of this type of chert are known from Istria (cf. Pellegatti 2009), and it is almost certainly from an exogenous source, most likely northern Italy (Scaglia Rossa or Scaglia Variegata). The second largest piece (not illustrated) is probably the same type of chert, but is heavily burnt with thermal fracture scars. Unlike the first three pieces described, the remaining two (Fig. 16.5, 2, 4) show signs of water abrasion suggesting long exposure to wave action. The larger of these is also probably non-local chert, but from an unknown source. Superficially it resembles a core fragment, although the degree of abrasion makes it difficult to tell if this is an artefact or an unworked nodule fractured by natural processes.

The presence of three chert objects from (apparently) non-local sources raises the question of how they reached Veštar Bay. Were they brought there by prehistoric people, e.g. as raw material, or were they ballast stones from ships entering the bay?

Cape Gale near Peroj, Istria

In 2004 a small-scale survey was conducted along the coast of Cape Gale near Peroj (Fig. 16.1). This led to the recovery of a large chipped stone assemblage. Initially, material was collected on the gravel beach. During subsequent surveys, however, it was observed that at low tide numerous stone, pottery, and faunal remains could be found on the seabed at depths of up to 50 cm. In spite of these observations, no underwater survey has yet been undertaken, and the extent of the submerged part of the site is still unknown. A total of c. 500 chert and other stone tools were collected, among which are ground-edge tools, and numerous chipped stone tools and debitage. They include arrowheads, end-scrapers, piercers, and prismatic blades. Although the pottery from the site is very eroded and fragmented, ‘brushed decoration’ is still visible on the surface of some sherds. The chipped stone tools and pottery can be dated typologically to the period from the Late Neolithic to the Early Bronze Age. The evidence points to the existence at Cape Gale of at least a partially submerged prehistoric site.



Veruda Bay, Pula

Veruda bay (Fig. 16.1) is a narrow inlet about 2 km long, which separates the town of Pula from the southernmost part of Istria. The bay is generally less than 2 m deep and, being surrounded by hills, is relatively sheltered from winds from most directions. During the 1980s the Marina Veruda was built in several phases along more or less the entire eastern shore of the bay. Construction of the marina required deepening of the harbour. Soft sediments dredged up from the seabed over an area c. 250 × 100 m in the inner part of the bay were deposited on land at the head of the bay. A diverse assemblage of prehistoric and Roman pottery sherds, stone artefacts, and animal bones was later recovered from this redeposited material, and presented to the Archaeological Museum of Istria in Pula (Mihovilić 1992). Among the lithics are two polished axe-heads made from volcanic rocks (one complete, the other a proximal fragment of a shaft-hole axe) and chipped stone artefacts made from local (central Istrian) dark grey to black chert, including side- and end-scrapers, piercers, backed tools, a bifacial leaf-shaped point (interpreted as a spearhead or dagger blade), and long prismatic blades. Although likely a mixed assemblage, the lithic artefacts were compared to those from Neolithic–Early Bronze Age sites in the northern Adriatic region by Mihovilić (1992: 87–8), while Bernadini *et al.* (2009) attributed the shaft-hole axe more precisely to the Copper Age.

Figure 16.5: Lithic material recovered from Veštar Bay (Photo: L. Bekić)

Oruda

To the south of the small island of Oruda (Fig. 16.1) west of Lošinj, there is an islet, called Palacol. During the investigation of a Post-Medieval wooden shipwreck in the summer of 2010 pottery sherds were discovered at a depth of *c.* 5 m. The location of the shipwreck is *c.* 100 m south of Oruda and *c.* 50 m north of an unnamed rock protruding from the sea. About a dozen of the sherds (Fig. 16.6) are thought to be of a prehistoric origin, and therefore unrelated to the shipwreck. Most of the ceramics were found directly on the seabed, and were abraded owing to the strong currents at this location. They are hand made, unevenly fired, with crushed calcite temper. Three sherds are from vessels with a wide, rounded body, a horizontal, nearly straight, cylindrical neck, and a very slightly everted rim (Fig. 16.6, 1, 3) or non-everted, straight rim (Fig. 16.6, 4). One potsherd (not illustrated) has no calcite temper, but is also likely to be prehistoric. None of the sherds bears traces of ornamentation. Typologically, the sherds are typical of the Copper Age in the

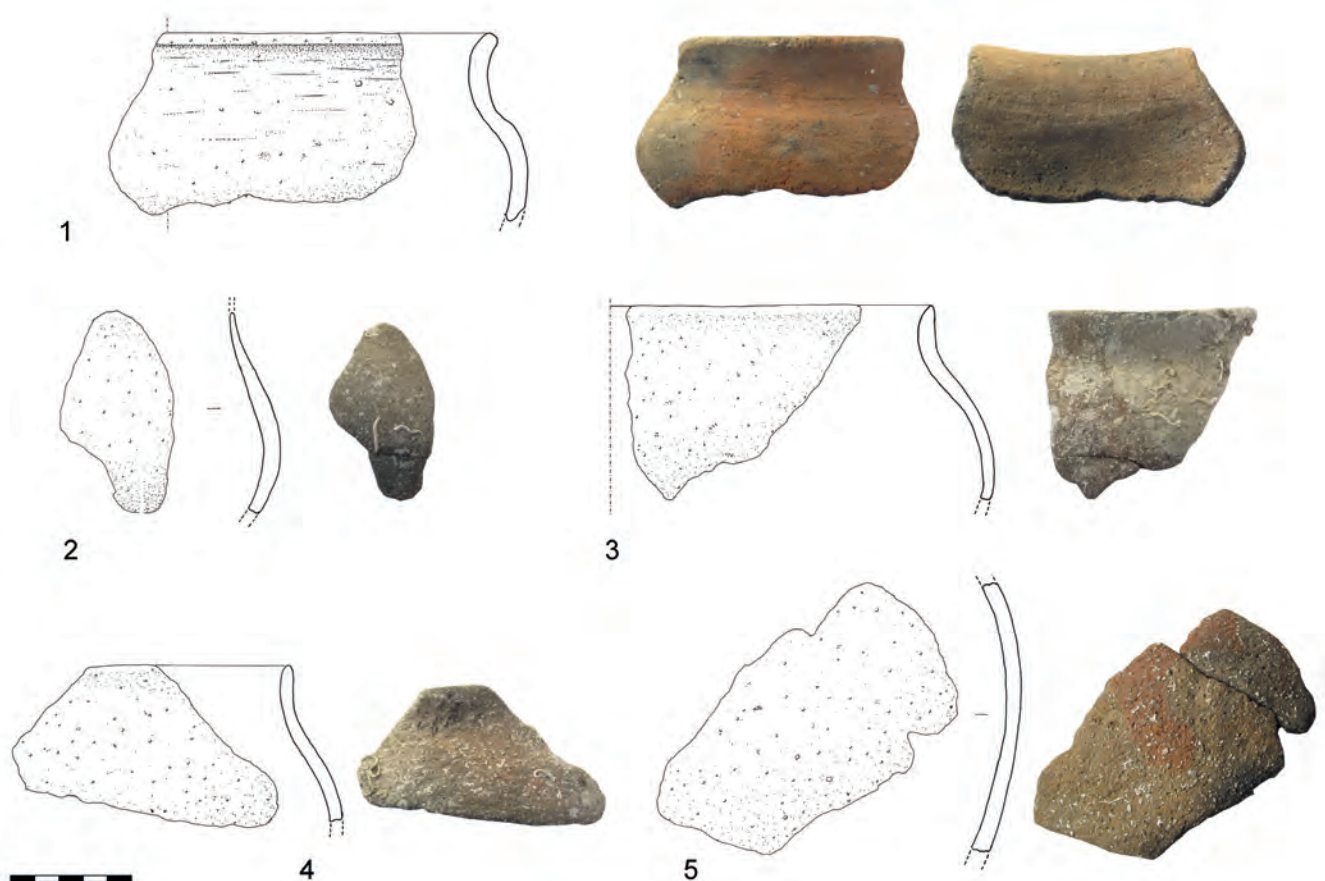
Istria and Kvarner regions. The best-preserved piece (Fig. 16.6, 1) was excavated with a dredge from underneath the shipwreck – an indication that there may be other well-preserved artefacts in the seabed sediments.

Some 30 m to the west of the shipwreck a linear stone feature, approximately 10 m in length, protrudes from the sandy seabed. Given its depth below sea level this is also likely to be prehistoric, perhaps the remains of a wall or causeway between Oruda and the rock to the south.

Zadar–Šibenik (Stipanac)

Brusić (1977) reported the first underwater finds of prehistoric artefacts along the east Adriatic coast in a publication that focused primarily on later material. He described the results of underwater surveys along the coast between Zadar and Šibenik in central Dalmatia (Fig. 16.1). Prehistoric pottery and chipped stone artefacts were recovered from the seabed, usually in close proximity to islets just offshore, although few details of the finds or their contexts are

Figure 16.6: Prehistoric ceramics found near Oruda (Photo: L. Bekić)



available. A series of chert artefacts found on the seabed near Stipanac islet were identified by Brusić (1977) as 'Palaeolithic', and more precisely by Malez (1979) as 'Mousterian'. However, these chronological interpretations cannot be verified on the basis of the published descriptions or illustrations (Fig. 16.7).

Baška Voda

In 2002 non-archaeological divers recovered a small group of lithics from the seabed near the Dalmatian coastal town of Baška Voda (Fig. 16.1). The objects were discovered when efforts to dislodge a boat that had run aground in the harbour resulted in a 'trench' some 30–40 cm deep in the seabed. The find spot was recorded as approximately 50 m from the shore (now a harbour wall), roughly in the centre of the harbour. The lithics are reported to have been found at a depth of c. 5–6 m (T. Jurišić, pers. comm. 2009), but no information is available on their geological context – thus, it is not known if, prior to disturbance, they lay in the reworked sediment on the seabed or were stratified in an older, pre-transgression deposit. They were reportedly found together as a group, and show no signs of natural abrasion caused by stream or wave action. Whilst this might suggest they were *in situ* or had not moved far from their original place of deposition, it does not exclude the possibility that they were redeposited in containing sediments during harbour construction or operations. Another possibility is that the lithics were intentionally deposited in the sea, either as refuse or as a ritual act. Some sherds of Roman pottery were also found in the vicinity, but where these occurred in relation to the lithics and whether they were deposited at the same time, which would imply secondary deposition of all the material, is not known.

Of the six lithic pieces recovered, five are now housed in a private collection in Baška Voda, where they were examined and photographed by Jonathan Benjamin (Fig. 16.8). They comprise two prismatic blades, an amorphous core, a fragment of a ground-edge implement, and an unworked chert 'chunk'. The longer blade (Fig. 16.8, 1a–d) is c. 19 cm long, tapers to a point, and is made of reddish-brown chert. There is light retouch along the distal half of one edge, resulting in a slightly denticulated edge outline. Both lateral edges show slight rounding probably caused by use or hafting since the dorsal ridges are sharp. This piece may have served as a knife

blade. The shorter of the two blades (Fig. 16.8, 3a–b) is made of a fine-grained siliceous rock (tentatively identified as quartzite). The dorsal ridges are sharp but both lateral edges are rounded, probably by use. The ground-edge tool (Fig. 16.8, 2a–c) is a fragment of an axe-head made from grey-brown chert. The core (Fig. 16.8, 4a–c) is an irregular fragment of yellowish-brown chert, exhibiting scars left by several flake removals.

The date of the lithic finds from Baška Voda harbour is uncertain, but the prismatic blades and the ground-edge tool can be paralleled in Neolithic or Chalcolithic sites along the east

Figure 16.7: Lithic artefacts from the seabed near Stipanac islet, central Dalmatia (After Brusić 1977: fig. 15)

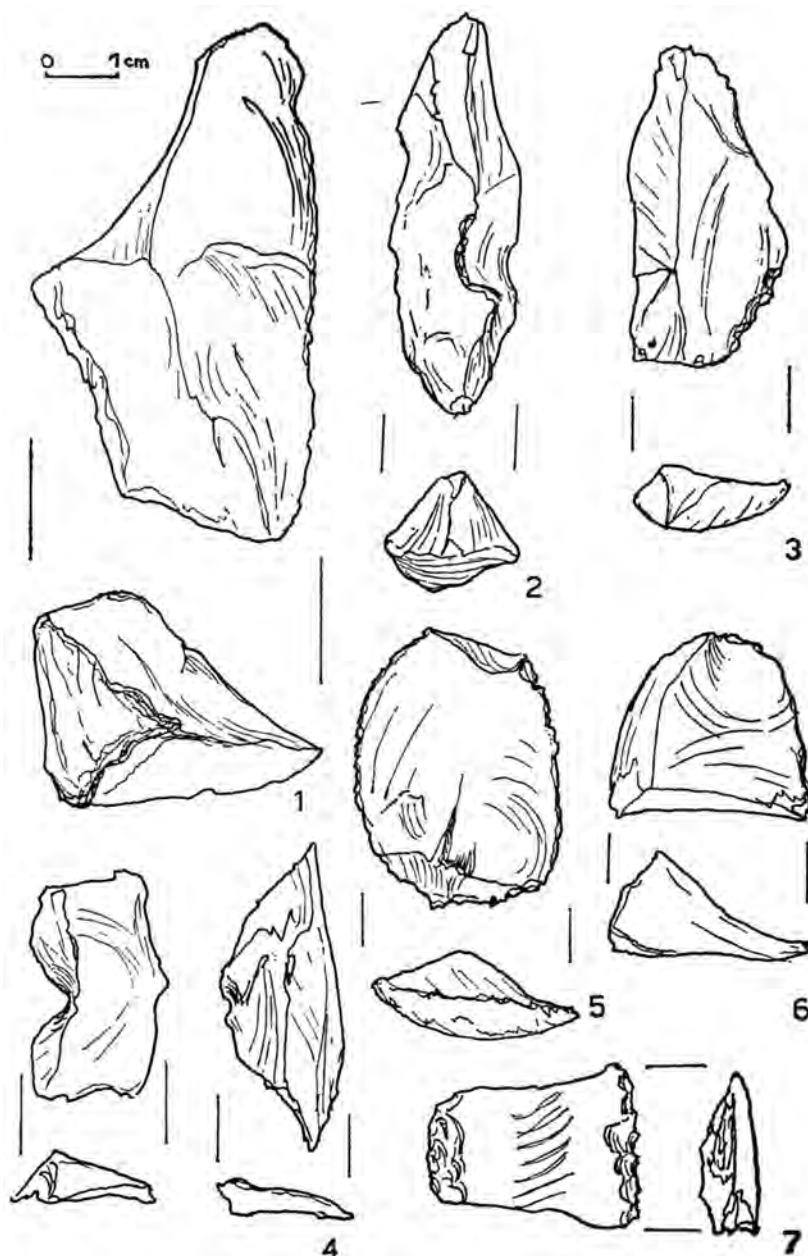




Figure 16.8: Lithic artefacts from Baška Voda. 1a–d retouched chert blade, 2a–c ground-edge tool fragment, 3a–b quartzite blade, 4a–c chert core (Photos: J. Benjamin)

Adriatic seaboard (cf. Mihovilić 1992; Čečuk and Radić 2005; Marijanović 2005; Brusić 2008).

Research in prospect

The preceding review of underwater prehistoric finds from the eastern Adriatic shows that most

discoveries have been made in fairly shallow water (<5 m deep) close to shore. To a large extent this reflects circumstances of discovery. The finds in Veruda Bay and Baška Voda were accidental discoveries during harbour construction or operations, while those in Zambratija Cove and Veštar Bay were made during underwater fieldwork that was directed initially at maritime features or deliberately focused on the nearshore zone. What little evidence is available pertaining to the age of the finds suggests most belong to the time range from the Late Neolithic to the Early Bronze Age.

A growing body of evidence shows that the pattern of sea-level change in the Adriatic over the past 10,000 years has resulted from the interplay of eustatic, glacio-hydro-isostatic and tectonic factors, with isostatic and tectonic effects being variable across the region. Consequently, sea-level curves constructed for different parts of the coastline differ in detail (Lambeck *et al.* 2004). The sea-level data for the eastern Adriatic from Trieste Bay to Dalmatia (Antonioli *et al.* 2007; Faivre *et al.*, in press) suggest that relative sea level rose from about -10 m to -4 m during the Late Neolithic to Early Bronze Age, c. 5000–1800 cal BC (Fig. 16.9). This should be treated as a rough estimation, since the tectonic contribution to relative sea-level change may not have been uniform along the northeast Adriatic coast, or through time.

Prehistoric people would have located their settlements *above* the contemporaneous sea level – at elevations beyond the reach of storm waves, at least. In sheltered locations along the east Adriatic coast, the difference in height between mean sea level and shore-related settlements could have been as little as 1.5 m. Taking this into consideration, the depths at which known or suspected Late Neolithic–EBA sites have been found are consistent with the sea-level estimates.

Underwater archaeology and the 'neolithization' of the eastern Adriatic

The Adriatic rim is acknowledged to have been an important conduit in the spread of farming through the Mediterranean and into neighbouring regions of Europe, but *how* and *when* this agricultural expansion occurred is contentious. The scarcity of Late Mesolithic sites in the region, and the radiocarbon gap that has been observed in some caves sites between the Late Mesolithic and Early Neolithic (cf. Biagi

et al. 1993; Mlekuž *et al.* 2008), have led some authors to suggest that demographic expansion of farming populations from the Aegean or southern Balkans was the dominant mechanism, with adoption of agricultural practices by local (Mesolithic) hunter-gatherers playing only a minor role. A popular theory envisages pioneer leapfrog colonization along the coast and subsequent infiltration of the hinterland (Forenbaher and Miracle 2005).

Current ideas about the origins of the Neolithic of the eastern Adriatic littoral inevitably derive from land-based research. However, the spread of farming through the region took place when sea level was significantly lower than today; hence the coastal margins of the landscape occupied by the first farmers and their Mesolithic predecessors are now largely submerged. Any detailed investigation of these submerged landscapes requires underwater exploration, and there are two important questions with a critical bearing on current perceptions of the transition to farming in the Adriatic region, which will only be adequately addressed through underwater archaeology:

1. Were Late Mesolithic and Early Neolithic populations concentrated along the now submerged coastline?
2. What role did seafaring and coastal resources play in the lives of the last hunter-gatherers and first farmers of the region?

Establishing research priorities: where to look?

The critical period is between 7000 and 5500 cal BC. Sites with Impressed Ware pottery

and evidence of stockraising and/or cultivation are found in northwest Greece and western Albania before 6000 cal BC (Sordinas 1967, 1969; Schuldenrein 1998). Permanent farming settlements were established in the Zadar region of Croatia by 5900 cal BC (Moore *et al.* 2007, in press), although Neolithic sites are not known from the Trieste Bay area at the head of the Adriatic before *c.* 5600 cal BC (Biagi *et al.* 2008; Mlekuž *et al.* 2008).

Data for the northeast Adriatic (Fig. 16.9) suggest that relative sea level rose from *c.* -27 to -13.5 m between 7000 and 5500 cal BC. This serves as a rough guide to the possible locations of shore-related sites belonging to the Final Mesolithic to Early Neolithic time range, and provides a benchmark for future underwater surveys. Such depths are accessible to archaeological divers using standard scuba equipment and compressed air.

Post-transgression sedimentation will also impact on the prospects for underwater site discovery. Rivers draining the Trieste Flysch, which comprises interbedded sandstones and marlstones of Eocene age, have deposited large amounts of sediment in the northern Adriatic basin and, locally, along the northern coast of Istria, sedimentation rates during the Holocene have been quite high. The average rate of sediment accumulation in Piran Bay has been estimated at 3 mm/year (Ogrinc *et al.* 2005) and similar rates may apply in the inner bays of Koper and Trieste. It follows that any shore-related sites in these areas dating to the

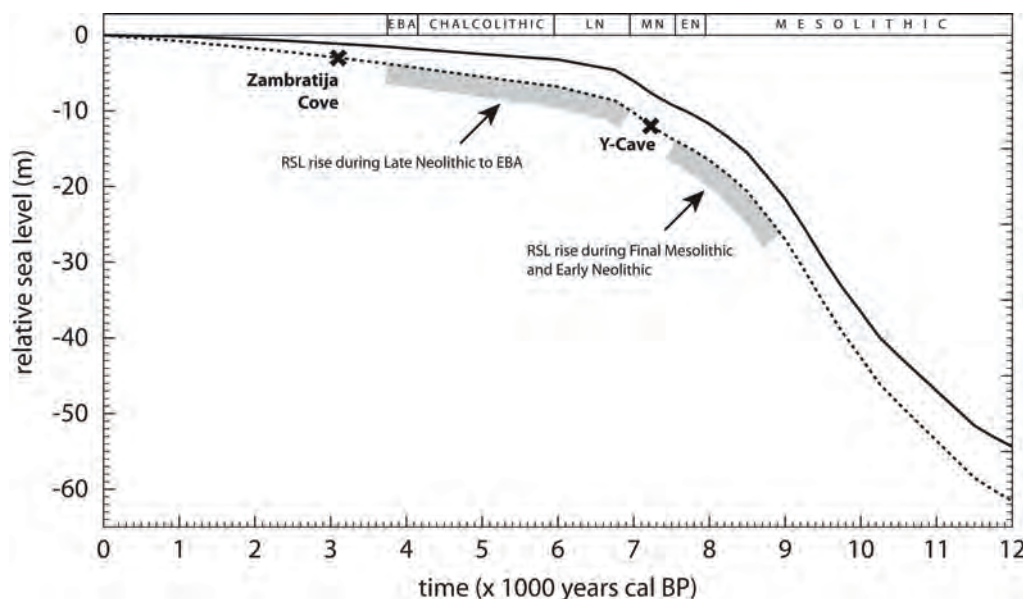


Figure 16.9: Predicted Holocene sea-level curve for Brijuni, northwest Croatia, in relation to the regional archaeological chronology. The solid line represents the eustatic change (After Antonioli *et al.* 2007). The dashed line is 'corrected' for tectonic subsidence averaging 0.6 mm/year, as estimated by Faivre *et al.* (in press) for the period 4–2 cal ka BP. EN Early Neolithic, MN Middle Neolithic, FN Final Neolithic, EBA Early Bronze Age, RSL relative sea-level. The altitudinal positions of the submerged Zambratija prehistoric site and Y-Cave are marked on the 'corrected' curve (Drawing: C. Bonsall)

Mesolithic and Neolithic might be quite deeply buried.

South of Piran, however, along the Istrian and Dalmatian coasts, which are underlain by mainly carbonate rocks, sedimentation rates are generally much lower. It follows that the prospects for identifying archaeological finds or features on or just below the seabed are significantly better – it is hardly a coincidence that nearly all the prehistoric underwater finds to date have come from this part of the Adriatic.

Focus on the Zadar Archipelago

Any study of a submerged landscape should be preceded by familiarization with the geology and geomorphology of the region, together with a review of the existing archaeological and ethnographic data (for discussion, see Benjamin 2010).

The region between Zadar and Šibenik on the Dalmatian mainland has some important Stone Age sites (Chapman *et al.* 1996; Forenbaher and Miracle 2005; Komšo 2006). The Zadar archipelago with its hundreds of islands and islets created by the post-glacial marine transgression, therefore, seems an obvious place to begin the search for submerged shore-related sites belonging to the Mesolithic–Neolithic transition period.

At 45 km long and 124 km² in area, Dugi Otok (*Long Island*) is one of the larger islands in the archipelago. During the Last Glacial Maximum *c.* 20 ka BP, when sea level stood at *c.* -120 m (Fairbanks 1989; Blanchon and Shaw 1995), Dugi Otok was a ridge of high ground at the eastern edge of the now submerged Adriatic Plain. It became an island *c.* 12,000 BP/11,900 cal BC during the post-glacial marine transgression, evolving into its present form as sea level continued to rise during the Holocene. The island has not been intensively researched archaeologically, but land-based reconnaissance surveys mainly in the 1960s and 1970s produced archaeological finds of various periods, some claimed to date back to the Palaeolithic (Batović 1993). A small test excavation in Vlakno Cave uncovered evidence for the exploitation of marine resources (shellfish, crab, fish and octopus) during the Early Mesolithic, *c.* 10,000–9000 cal BC (Brusić 2005; Komšo 2006).

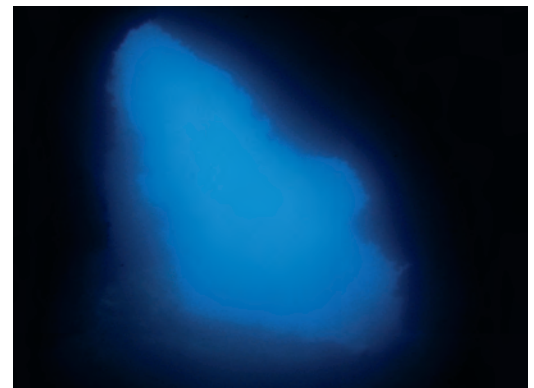
Dugi Otok is a promising target for underwater survey, because it has:

1. A settlement record extending back more than 11,000 years.
2. A karstic landscape rich in caves, including several known undersea caves.
3. A coastline with localized low wave energy environments (straits and protected embayments) and generally low seabed sedimentation rates, which increase the likelihood of underwater archaeological preservation and discovery.
4. A productive marine environment that has been exploited since at least the beginning of the Holocene.

Of the undersea caves recorded around the island, Y-Cave near Brbišica Cove (Fig. 16.10) is the best documented. Geological divers conducted a survey of the cave, noting its potential for prehistoric human habitation (Juračić *et al.* 2002). The cave entrance is *c.* 6 m high, and the presence of speleothems (calcium carbonate deposits formed by the action of water) suggests the former existence of a freshwater spring within the cave. Fine sediments cover the cave floor, which suggests minimal disturbance by wave and current action; and there is an absence of rock debris that could impede archaeological investigation. Moreover, the orientation of the main passage is similar to that of nearby Vlakno Cave (see above). Given its depth (12 m) below sea level, Y-Cave is unlikely to have been transgressed until after 5500 cal BC, and so would have been available for human use during the Mesolithic and, possibly, well into the Neolithic.

Prehistoric peoples often made use of caves for economic or ritual purposes whilst living in open-air settlements (for discussion, see Tolan-Smith and Bonsall 1997). Any study of the submerged prehistory of Dugi Otok, therefore, needs to include systematic surveys of palaeotopographic features within protected embayments, straits, and around river mouths

Figure 16.10: The 'daylight zone' inside Y-Cave, Dugi Otok. The cave entrance is *c.* 6 m high. Submerged sea caves are abundant along the Dalmatian coast and represent a potentially important archaeological resource (Photo: J. Benjamin)



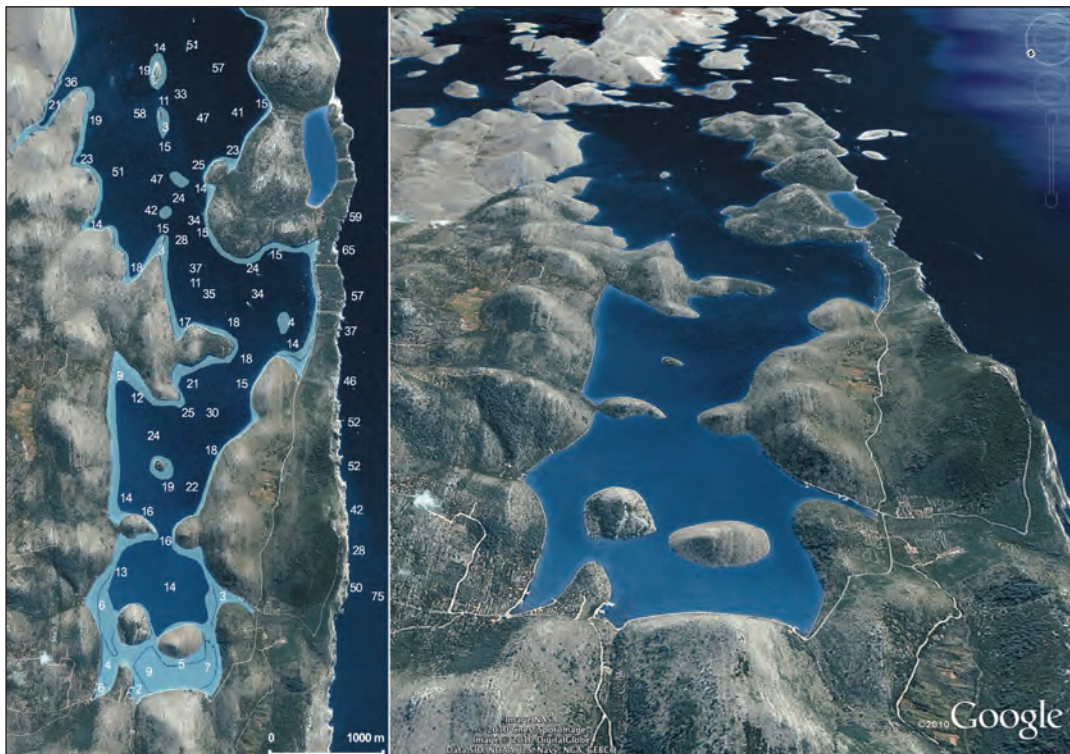


Figure 16.11: Southeast-facing oblique satellite image showing the sheltered environments of Telašćica Inlet on Dugi Otok. Left: generalized bathymetry. The inlet is approximately 8 km long (Image © Google Earth)

and promontories where open-air residential sites, fishing camps, and fixed installations might have been located prior to submergence.

Telašćica is a large inlet at the southeast end of Dugi Otok, with numerous small bays, headlands, and islands (Fig. 16.11). Sea-level rise data suggest the inlet came into being in the Late Glacial and evolved through the Holocene as sea level continued to rise. The inlet has several characteristics that make it attractive for underwater archaeological exploration aimed at identifying submerged Mesolithic and Neolithic sites. These include: (i) evolving shorelines and sheltered marine environments that would have been accessible from the Upper Palaeolithic onwards; (ii) localized areas of fertile soils in close proximity to the shoreline; (iii) a known concentration of prehistoric sites at the head of the inlet (cf. Batović 1993); (iv) numerous low wave energy environments with high archaeological preservation potential; and (v) water depths that are easily accessible to archaeological divers.

Research strategy and methodology

A systematic study of the submerged prehistory of Dugi Otok would include the following elements (cf. Benjamin 2010; see also Lübke *et al.* and Westley *et al.*, this volume):

- review and assessment of previous research (desk study);
- familiarization with the regional geology, geomorphology, and hydrology;
- ethnographic survey;
- mapping of the palaeolandscape and evaluating its archaeological potential;
- palaeoenvironmental sampling;
- archaeological testing.

Several authors have stressed the importance of using underwater archaeology to supplement the (often eroded and weathered) record from adjacent terrestrial sites (e.g. Wilkinson and Murphy 1986). It follows that an integrated approach is desirable, in which the submerged landscape research is preceded by an assessment of the land-based evidence. Field inspection of adjacent terrestrial sites, including topographic surveys where these have not already been done, might aid interpretation of the submerged landscape. On Dugi Otok, for example, an assessment of the topographic setting and archaeological evidence from Vlakno Cave should precede any archaeological investigation of the submerged Y-Cave.

Research by Fischer (1993, 1995) in the western Baltic has demonstrated the value of *ethnographic research* in helping to identify submerged prehistoric sites (for further

discussion see Benjamin 2010). Ethnographic interviews with local fisherman on Dugi Otok, especially those elderly residents who practised traditional fishing methods before electricity and refrigeration were introduced to the island around 1960, are an essential prerequisite for any study of the submerged prehistory of the island. The information gained regarding the species of fish and shellfish targeted, the capture and processing methods employed, and the locations where particular activities were carried out can inform the interpretation of previous archaeological finds as well as underwater survey strategy.

Mapping of submerged landscapes can be done at different scales and resolutions, with variable cost implications. One approach would be to use the available (consumer grade) bathymetric charts for the waters around Dugi Otok to provide basic, low-resolution data on the topography of the broader palaeolandscape, followed by higher resolution studies of smaller areas like Telašćica inlet and the environs of Y-cave, with the standard bathymetric data being supplemented by more sophisticated sonar or marine-based LiDAR surveys. Bathymetric data alone, however, can fail to detect small-scale landscape features, such as palaeochannels, especially where these are infilled with marine sediments. Therefore, we would advocate the use of sub-bottom profiling (where cost-effective) and/or corer/auger sampling in order to provide geotechnical data and 'fine-tune' palaeotopographic reconstructions. The resulting palaeolandscape record could then be used to create a map of 'archaeological potential' highlighting topographic features that may have been used by prehistoric people for settlement or subsistence-related activities, combined with an assessment of the potential for archaeological preservation.

Once the baseline data have been collected and analyzed, focused sampling for palaeoenvironmental and archaeological evidence would be conducted in high-priority locations. Palaeoenvironmental sampling would be aimed at identifying biogenic or fossiliferous deposits (e.g. shell beds), and collecting samples for radiocarbon and environmental analysis. In caves, augering can also help to determine the extent of roof collapse, the likelihood of archaeological discovery based on sedimentation type, and the presence of deposits likely to contain cultural materials. The data recovered may also contribute

to regional reconstructions of sea-level change and coastal environments. Archaeological testing, which is partly dependent on water depth and time constraints associated with scuba diving, may encompass a variety of standard underwater methods ranging from simple hand fanning (where seabed sediments are thin) to (manual or dredge-assisted) test-pitting.

Conclusions

Large areas around the Adriatic Basin that were once settled by prehistoric populations have been submerged as a result of sea-level rise since the Last Glacial Maximum. This chapter has reviewed the current state of research into the submerged prehistory of the eastern Adriatic and outlined the potential for larger-scale studies aimed at addressing major research questions.

At least eight submerged sites or localities with prehistoric artefacts have been reported along the east Adriatic coast between Piran in Slovenia and Makarska in Croatia. In most cases the finds were made close to shore in water less than 5 m deep. Several sites contained pottery and stone artefacts that indicate a Late Neolithic to Bronze Age date, and it is likely the sites were located on or near the coast at the time of their occupation. One site, Zambratija Cove in Istria, has well-preserved structural remains and organic materials that offer the possibility of high-resolution radiocarbon (and perhaps dendrochronological) dating. In turn, precise dating of (potentially) shore-related sites like Zambratija, would contribute to a better understanding of relative sea-level change and shoreline displacement during the Holocene.

Shore-related sites belonging to earlier prehistoric periods would lie at greater sea depths. On present evidence relative sea level rose from *c.* -27 to -13.5 m during the period between 7000 and 5500 cal BC, corresponding to the Final Mesolithic and Early Neolithic, and such depths are accessible with standard scuba equipment and compressed air. The transition from Mesolithic to Neolithic is a crucial but under-researched period in the prehistory of the eastern Adriatic, and there are important issues relating to the origins and spread of farming in the region that can only be addressed through submerged cultural landscape studies. We have presented a research design for one such study focused on Dugi Otok, a large island in the outer Zadar archipelago in northern Dalmatia.

By drawing attention to extant underwater prehistoric finds and the prospects for more extensive and systematic underwater research and site discovery along the Istrian and Dalmatian coasts, we hope to have demonstrated that the eastern Adriatic has considerable potential for the survival and investigation of submerged cultural landscapes. We suggest the archaeological exploration of these palaeolandscapes should be given a high priority, since it could have a profound impact on our understanding of the prehistory of the Adriatic basin and, by extension, the wider Mediterranean.

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